Laboratory Practices in Earth Sciences: Landscape Mapping

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Week- 03
Lecture- 15

So, welcome back, in the previous lecture we discussed a few important points related to the drainage basin evolution or formation of the drainage basin and we were talking about the floods and all that. So, we will just look at a few more slides of the floods and then we will move to the channel pattern and drainage pattern part. Now, this is the Shiva statue which was constructed in Haridwar which was 15 feet high and which can be viewed from far distance, but what happened during the floods there. So, this was the amount of water and the volume of water which affected the area. So, again the channel was in a flooding state during this time. Now, the important part is what we were able to connect now with this hydrological cycle.

So, what are the processes which are involved here? There is a very basic part which we have learned during the school time also that mainly it is a complete cycle where you have the evaporation from the land as well as the ocean then you have the formation of cloud condensation and then precipitation. Now once this comes down in another is also even through the transpiration. So, once the precipitation or the rain water falls on the surface then there is an infiltration and then we may have further percolation within the earth surface and then another important part is your runoff. So, this infiltration or you can say percolation plays an important role in minimizing your surface runoff.

So, if you have less infiltration more will be your runoff and if you have more infiltration less will be your runoff. So, these are interconnected processes which we have in the hydrological cycle. So, what it implies is that what we were talking about is that you are putting yourself in front of the fluvial system or and then that increases the risk or hazard. So, this is exactly and even if you are blocking the areas of the older drainage system and putting the construction there. So, what exactly you are doing is increasing or you can say that you are decreasing the infiltration and you are increasing the runoff.

And then this is what is happening that increasing runoff will eventually lead into flooding conditions. And in many locations, we have come across that this flooding state will be achieved very fast in no time you will see and this is mostly seen in the urban areas. So, the process is very simple here. If you are having less infiltration percolation, more will be your runoff, more infiltration percolation, less will be runoff. So, this will reduce flooding. It may get into a flooding state, but it will take more time.

So, this is a simple connectivity between the infiltration part and your runoff. So, this is the process just between what we were discussing precipitation and you have filtration percolation and surface runoff. So, this is also the same part you have. So, these are interconnected. Now, if you try to look at what we were talking about, the longitudinal profile or the river profile.

So, let us look at the dynamics of the river system. So, what we see is that from the source you are having steeper gradient the particles are coarser shallower gradient in the medial part medium sized particles and then mouth towards the mouth what you see is the finer particles and also the gradient is decreasing steeper shallower here. So, generally particle size may decrease downstream. So, you are moving in the downstream direction your particle size is reducing from coarse to finer. Gradient decreases that what we see is that steeper gradient here you are having shallower gradient and it shallows down further.

However, discharge carrying capacity and velocity increases downstream. So, this is what we discussed in the previous one, but you should note down this part also. And this is true for the area with good rainfall whereas, in tri- climatic zones water loss due to evaporation and infiltration results in decrease in discharge downstream. So, depending on which area we are looking at this will vary, but in general this is what you will see that upstream are steeper velocity will be higher here coarser particles or the and then further it increases. So, comparatively it increases the velocity increases downstream, but the gradient reduces the grain size decreases and so on.

So, this is in short, the overall dynamics of the weaver. So, there is another illustration which has been shown that in the upper edges close to the source and all that in the uplands you will have coarser material and slowly towards the downstream you will see the finer one. And as we have discussed that comparatively the velocity will increase downstream and of course, the carrying capacity also increases. And another part which is apart from the or we can say in association with this the slope and all that the landforms will vary from the upstream to downstream and that what we will we will try to see. So, to study this landform mainly there is a branch of earth sciences which we call geomorphology and that is the morphology of the surface mainly we try to look at how it looks and what the different undulations tell us about the system.

And in particular if we look at it because the erosion on the surface is resulting in the formation of the landform. And there are three agents: the river wind and glacier or ice action results in erosion and the sculpturing of the landscape on the earth surface. But in particular related to the river activities we term this as a fluvial geomorphology and as I said that the fluvial world is related to your river activities and all that. So, mostly we will

be going to talk about the fluvial geomorphology and all that. So, the river system goes right from the source to the area where it is debauched.

It is like you have the headwaters and the mouth area and this is what we are. We will talk about the longitudinal profile. So, this is your longitudinal profile over here. So, what we see is we can divide this into three: we have the tributaries then we have the trunk stream and we have the tributaries. So, mostly in short if I draw this then how it appears is that you have the tributaries which are joining here and then you are having the trunk stream and then where it is debauching is like distributed here. So, this is you distribute trees, this is your trunk stream and these are tributaries.

So, the tributaries not only just will be seen in the headward area, but you will see in between through its journey. So, it looks something like this. What we see is that these are the headwaters of the stream. So, you will have the small streams or the tributaries which are connecting the trunk streams and then you have what you are getting into. So, these are the things we can mark as an in portion of the medial part. There is an upland here and the piedmont zone and this is the area where you will have the flood plains. And if you try to recall what we see from the Indian subcontinent is that we have in flat land here what we call endocancetic plain and then we have the Himalayas.

So, this is the uplands from which the rivers are flowing and then we are getting into the. So, the endocancetic plain is mostly where most of the rivers have their floodplains. And this is your you can say the headwater areas or the upstream part or the you can say the tributaries which are pouring water to the main trunk stream. Now, this part we have already discussed about the drainage divide, but you can easily denmark it based on the understanding that you are having the slope in a different direction here. So, this will form your drainage divide and if you connect the overall drainage divide then there will be your drainage basin for that particular area and the trunk stream is seen over here.

So, this is the main stream which is flowing and these are the tributaries which are flowing in. Now, you can even have the sub basins here. So, you will have these sub basins which are seen here, these are all sub basins smaller ones. So, you have the main trunk stream basin and these are all sub basins. So, a river system consists of a main channel that is what is a trunk stream and all of the tributaries that flow into it or joining the trunk stream.

River system can be divided into 3. What we have discussed is your collecting system consisting of the network of tributaries in the headwater areas that collect and funnel water and sediments. So, this is coming as a bed load here to the main trunk stream then transporting system. So, the trunk stream will carry all the material which has been supplied to it further downstream and that will also be responsible for the erosion and deposition

and that will lead into the formation of different landforms. And finally, what we call the dispersing system consists of a network of tributaries and these are usually seen when any trans stream or the main rivers debauchage into the ocean or any water body. So, you have branches that are your collecting system, trunk that is your transporting and roots that are your dispersing system.

Stream flow and sediment transport, rivers are not fixed structures like roads, they will keep changing. So, this is also why we will talk about when we are looking at the landforms in the endogenetic plains because we need to understand how this channel will shift or they will migrate from one place to another place. They are not the fixed structures on the earth surface. Subject to change their course under the influence of natural processes, rivers are complex network interconnected channels with tributaries responding to change due to regional climate change or local weather or amount of variability in the flow and sediment supply and size. So, sometimes what we see is that if there is an excess amount of sediments coming into the trunk stream or the main channel the pattern will change. It can also result in the formation of natural lamps that are your ponding condition and the ponding condition will result in the downstream changes of your channel pattern and all that.

So, these are few things which one can easily try to understand, identify and demark using the remote sensing data. Now, in general we have like three major channel patterns. So, these are the channels that we are looking at and the drainage pattern we will look at later. So, one is your straight channel pattern, second is the meandering and third is the braided one. So, these are the three main channel patterns and we can have the combination of these three also.

So, we will see how they are responsible for the formation of the landforms and how dangerous they are in terms of the hazard also. So, in the straight channel what you see is that the maximum velocity will be in the central portion. That is your pool will be in the central portion and that will have a tendency of erosion. So, this portion will be deeper. So, if you look at this cross-sectional profile here, then you will see something like what has been shown here.

So, you have a gentle part here, but this portion will be deeper. So, this is a deep, deeper part. Second is your meandering channel. A meandering channel the darker blue portion is shown here, this is the deeper portion. And if you see this one here similar to this because this is an outer edge of the channel, the channel is flowing in this direction.

So, this is an outer edge. So, this is an erosional one. So, this is an erosional bank you will have and this side you will have the deposition. So, on one side the inner portion is in the positional bank and the outer portion is your erosion. So, what we see here is again as

compared to this portion is deeper and this one will be shallower. If you look at the cross section this is what has been shown here that this you are having shallow and thus you move further towards the erosive side this will become deeper.

So, this is another important part which you should remember in terms of the meandering channels. So, outer part erosional deeper higher velocity again this will have higher velocity whereas, this will be having lower. So, erosional you will have deeper higher velocity whereas, this one will be depositional shallower and lower velocity. Again, another example if you look at it, what you see is the outer side. So, it reverses this with the arrow which has been shown here.

So, you have the flow direction on this side here. So, what you see is that this is the erosion erosional side whereas, the inner portion of the channel is you are having. So, one when you are having a meander. So, when we are talking about the meander it is that it is a sinus channel. So, this will be if it is flowing like this or it is flowing like that it will be the same.

So, if you say that the river is flowing in another direction here. So, this will be your outer and this will be your inner. So, this is what you will see. So, in both cases you will see the same pattern. So, if you are having the direction here then this will be the part of erosion, this will be the part of deposition.

And the cross section that you see here as I discussed will be something like this. So, as you move towards the outer part this will be having a deeper side. So, this is having the deeper and also as I told that velocity will be higher velocity. So, we should know that if you are coming across such areas this portion should be avoided actually for the construction. So, this is a straight one as we discussed in the previous channel and will be more or less like this and in this case, we are having the outer here.

So, this will be erosional, this will be depositional and you are having the channel cross section will be seen like this. And this is what has been shown here is that if you take this portion over here this area and see what you look at here. So, you are having a tendency of the channel to migrate in this direction. Because this will keep eroding here it will erode here and there will be in deposition here and it will keep moving further. So, first it will come here and second it will go like this over here.

So, you will have an erosional pattern. So, I hope that you understand the meandering pattern and what are the different parameters which are related in terms of the erosion and deposition. Now, coming to the other part, actually this part also we will discuss later, but of the levees, but usually the levees are difficult to see in the field, but what if you take the cross sectional area of the cross section of the channel here. Then how it will look is that

you will see that there is an elevated portion here then you go down here and then you are having. So, this is mainly a levee. So, this has been termed as the elevated portion.

So, this will have a slope away from the channel. This will have a slope. So, it will be slightly higher here and then it will be sloping away from the channel and these are typically termed as the levees. We will come to this point we will discuss that what are the what are what are the importance of this levees and of course, in the floodplain areas the back-swamp formation of the back swamp is most common and if you see this one here this part I will show you later on also. So, this is nothing, but the old channel or I would say the old meander of the channel and similarly you can see here also.

So, close to the river you will see that you were having the wetlands and the back marsh which had developed within the floodplain region. And the back swamp or the wetlands that we are looking at are the areas of the older floodplain of the channels. So, rivers used to flow through this before, but later on it shifted and this is also an evidence of that. And what we were talking about was how the levees look. So, if you are having this sort of a typical levee formation then this area which is sitting over here is mostly used for settlements or you can say the construction.

Because, if the flooding state goes up to this then this area is safe. So, nothing is going to happen beyond that. So, a meandering pattern as we have discussed. So, in contrast to the braided channels we will come to this: what are the braided streams? Meandering rivers typically contain one channel that winds its way across the floodplain.

So, it will be like a sinus channel which you will see like that. And then you have this tight meander which will later on get cut off. So, as it flows it deposits sediment on banks that lie on the inside of the curves and the deposition is termed as the point bar deposits. This point bar deposit is also like they say that these are one of the landforms. So, you will see sort of what has been termed as point bars.

And this will be like a crescent shape. So, you will have the deposition of the landforms like that. And erosive banks that are here outside this one, this is your erosive banks will have the cliffs which are developed. So, now, when you go to any river bank or the river system you try to look at the cliffs and the point bars you will be able to judge that. So, we will stop here and we will continue in the next lecture discussing more about the meander channels and what are the different landforms we have associated. Of course, we have seen the point bar part. We will also see the other landforms which are developed which are commonly seen like terraces and all that. So, thank you so much.